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DEVICE AND METHOD FOR MEASUREMENT OF LASER ENERGY DISTRIBUTION

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ABSTRACT OF THE DISCLOSURE

A device and method of determining the energy of a laser beam wherein a stack of colored sheets is exposed to a laser beam to be vaporized to an extent dependent upon the instantaneous energy of the beam, thereby creating a streak of different colors indicating the distribution of the beam energy in time and space.

This invention relates to laser beam devices, and more particularly to a unique method and means by which to record and permit visual inspection of the energy distribution of laser pulses.

In laser welding techniques, it is known that the surface of an element must be properly liquefied for welding, and that the material and thickness of the element determine the energy distribution of laser pulses needed for this purpose. For example, for two elements of different materials and the same thickness, one may require that most of the pulse power be applied in a tenth of a millisecond, whereas it may have to extend over a period ten times as long for the other element.

For different thicknesses and materials of various kinds, it is necessary to make a permanent record of this information once it has been obtained. When one desires to weld an element of the type for which the energy distribution has been classified, he must adjust the voltage and capacitor settings for the laser and check its performance.

In this latter connection, the pulse type laser is provided with a voltage source which is coupled to a capacitor bank for building up the desired charge voltage. Both are variable, so that peak pulse power (watts per square centimeter) and the time duration thereof can be varied.

The techniques heretofore known for checking laser performance involve the use of complex and costly equipment. Typically, a special oscilloscope is employed for displaying a visible trace of the pulse formed on a cathode ray tube which measures the voltage taken from the output of a photodetector placed in the path of the beam, or the output of a calorimeter which measures the heat created at the object plane of the laser. An alternate method of measuring the laser output power is to record with an oscilloscope the high power current surge coming from the capacitor bank and powering the laser pumping lamp. This surge is proportional to the laser output. The time duration of a laser pulse is so short that the waveform displayed cannot be assimilated by the observer. Accordingly, means for retaining this image such as image storing oscilloscopes or a photograph of the cathode ray screen at the instant of firing, are required for the study of this display.

Such a technique of course requires circuitry to synchronize the operation of the camera with that of the laser. Needless to say, all the equipment required is quite complex and expensive. Even so, the record obtained, being a trace that appears on a grid, or screen, that is placed over the cathode ray tube, is not qualitative. One must still make a mechanical measurement of the height and width of the trace, and interpret what he measures.

Such equipment may cost considerably more than the laser itself. Taking into consideration the time and effort

involved in operating the equipment and evaluating the results obtained, it is apparent that it is quite expensive to set up a laser for a given operation and check its performance.

It is an object of my invention to provide unique means for making a record of a laser beam pulse which avoids the use of equipment and the consumption of time heretofore required.

It is another object of my invention to provide a simple mechanical means for obtaining a permanent record suitable for use in setting up a laser for desired operation and for checking its performance.

A still further object of my invention is to provide a method of quickly checking laser performance with a minimum number of steps.

Yet another object of my invention is to provide apparatus for moving a multi-layer record element in the object plane of a laser to obtain markings corresponding to the distribution of beam energy in time and space.

It is also an object of my invention to provide a multilayer record element and operable means therefor to record energy distribution of a laser beam, which comprises a minimum number of component parts of simple design and rugged construction, and which is inexpensive to produce and operate.

The above and other objects and advantages of my invention will become apparent from the following description taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a schematic diagram of a laser with charging and triggering means, a deflecting mirror in the path of the laser beam, and a focusing lens for focusing the deflected beam at an object plane, and showing, in accordance with my invention, the end view of a drum having an encircling multi-layer record strip thereon on which the beam impinges;

FIGURE 2 is a side elevation view of the drum with the strip thereon;

FIGURE 3 is an end view of spaced rollers carrying a record strip in accordance with my invention, wherein the portion of the strip struck by the beam is horizontal;

FIGURE 4 is an end view of a rotatable deflecting mirror disposed in the path of the laser beam, the beam being located between record strips carried on the confronting surfaces of arcuate members;

FIGURE 5 is a fragmentary top plan view of the record strip, showing the portions of different layers exposed by beams of different energy distributions;

FIGURE 6 is a fragmentary sectional view taken along the line 6—6 of FIGURE 5;

FIGURE 7 is a fragmentary sectional view taken along the line 7—7 of FIGURE 5;

FIGURE 8 is a fragmentary sectional view of another multi-layer record strip, to further aid in explaining the utility of my invention; and

FIGURE 9 is a side elevation view of an embodiment of my invention in which a multi-layer disc is carried on a turntable.

Referring to FIGURE 1, there is depicted a laser 10 to which the charge from a capacitor bank 11 is to be applied upon application of voltage from a trigger source 12. The capacitor bank 11 is charged from a voltage source 13. When the trigger voltage is applied, the charge on the capacitor bank is applied to the laser pumping lamp stimulating the emission of a coherent radiation beam, all in a conventional manner. The beam extends at 14 to a deflecting mirror 15, from whence it passes at 16 through a focusing lens 17 onto an object plane 18, also in a conventional manner.

In accordance with my invention, a drum 20 is mounted below the object plane 18 on the shaft 21 of a motor 22, which preferably is a synchronous motor. A record strip